

Studies of Polymer Foam Morphology with  
FIR Laser Scattering

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ABSTRACT

We report on the experimental observation of peaks in the angular distribution of far-infrared radiation scattered from solid, low density polymer foams. The results are consistent with a description of scattering from density fluctuations within the foams.

SUMMARY

We have measured the angular distribution of scattering of far-infrared radiation from low density ( $<0.1$  g/cc) foams of poly(4-methyl pentene-1) (TPX) and polystyrene (PS). For such foams that are prepared by a phase separation process from a starting two-phase solution, we observe peaks in the angular distribution of the scattering that can be associated with density fluctuations within the foam. The density fluctuations are believed to have formed as the temperature of the two-phase system is quenched through the spinodal region of its phase diagram in a manner similar to that proposed for glasses.<sup>1,2</sup> Using the formulas developed by Debye and Bueche,<sup>3</sup> our scattering data leads to a determination of correlation lengths in the range of 50 microns to 70 microns for these foams. This finding is consistent with the expected range for polymers whose cell sizes are in the range from 10 microns to 30 microns, although this is thought to be the first evidence for such density fluctuations ever found in polymers.

Our measurements were made using a commercial CO<sub>2</sub> pumped FIR laser operating in the pulsed mode with methanol as the lasing medium, at output wavelengths of 42 microns to 292 microns and at output energies near 100 millijoules per pulse. The detectors were Golay cells with a sensitivity of  $1.5 \times 10^6$  volts/watt and a NEP of approximately  $5 \times 10^{-11}$  watts at 1 Hz bandwidth. Baseline scattering from about 1.8 cc of foam was detected with a typical signal-to-noise ratio of about 4/1 and peaks were observed with S/N ratios as high as 20/1. A representative set of data for TPX foam is shown in Fig. 1.

This work demonstrates the utility of long wavelength laser radiation as a probe for determining polymer morphology in a

nondestructive manner. Continued work will focus on using this method to further characterize polymer foams and to study the kinetics of the foam formation.

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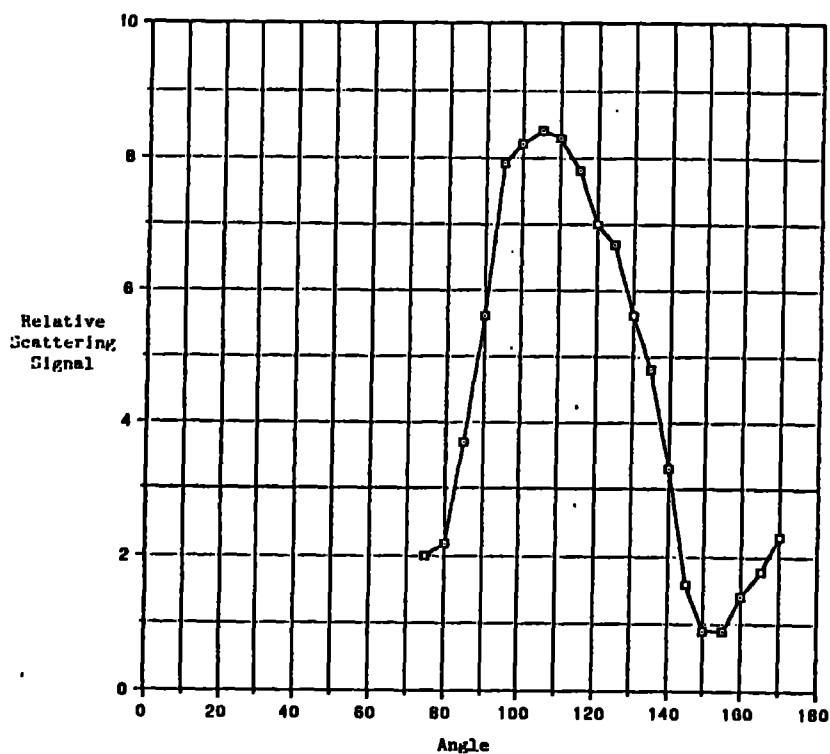


Figure 1

